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## Final Technical Report Dynamics Days Arizona 1993

ONR Grant Number N00014-93-1-0087

Period: January 5-9, 1993

Dynamics Days 1993 was organized by Eric Kostelich (Dept. of Mathematics, Arizona State University) and Robert Behringer (Dept. of Physics, Duke University). Other members of the organizing committee included Dieter Armbruster and Peter Crouch from Arizona State University. Meeting arrangements were made by Dr. Kostelich with assistance from the administrative staff in the ASU mathematics department. The workshop was held at the Tempe Mission Palms Hotel at the corner of Fifth Street and Mill Avenue in downtown Tempe.

This workshop attracted 230 participants, including 20 invited speakers, 30 contributed talks, and nearly 100 poster presentations. The program and the list of posters are attached.

A new feature of the 1993 program was the addition of a short course on chaotic dynamics, given on Tuesday, January 5, 1993 by James A. Yorke and Celso Grebogi of the University of Maryland (they were also invited speakers for the Dynamics Days workshop.) The morning program was conducted by Dr. Grebogi and covered the basic ideas of chaos: sensitive dependence on initial conditions, fractals, strange attractors, and the like. The afternoon program featured Dr. Yorke, who discussed the analysis of chaotic experimental time series. Topics included attractor reconstruction, noise reduction, short-term prediction, and control of chaos. The short course attracted some 80 people, about two-thirds of whom were graduate students.

Some of the scientific highlights of the conference included talks on the control of chaotic experiments (C. Grebogi, U. of Maryland; R. Roy, Georgia Tech, R. Rollins, Ohio U., M. Spano, NSWC) and tracking unstable periodic

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orbits as a parameter is changed (I. Schwartz, Naval Research Lab). Another focus of the meeting was pattern formation in physical systems. Alan Newell (U. of Arizona) discussed patterns in optics; I. Epstein (Brandeis) considered chemical patterns; and A. Winfree (U. of Arizona) discussed patterns in excitable media. There were about 180 attendees for the actual conference (some people attended both the short course and the conference).

The ONR grant of \$15,000 was crucial to the success of the meeting. The ONR funds provided travel and lodging support for the invited speakers as well as \$2500 in partial scholarships for graduate students and postdocs. (Approximately \$7,000 in support of the conference came from Arizona State University. These funds provided support for ASU graduate students to attend the short course and conference, and they also paid for postage and miscellaneous expenses. The remaining funds came from meeting registration fees.)

Dynamics Days 1994 is being organized by Robert Behringer (Dept. of Physics, Duke University, Durham, NC) and Eric Kostelich. The conference is scheduled for Jan. 5-8, 1994 at the Durham Omni Hotel in Durham, North Carolina.

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# DYNAMICS DAYS SCHEDULE

(Revised)

## TUESDAY, JANUARY 5 — Short Course

|               |                    |
|---------------|--------------------|
| 8:30 - 9:15   | Lecture 1          |
| 9:15 - 10:30  | Lecture 2          |
| 10:30 - 11:00 | break              |
| 11:00 - 11:45 | Lecture 3          |
| 11:45 - 12:30 | Lecture 4          |
| 12:30 - 1:30  | Lunch              |
| 1:30 - 2:15   | Lecture 5          |
| 2:15 - 3:00   | Lecture 6          |
| 3:00 - 3:30   | break              |
| 3:30 - 4:15   | Lecture 7          |
| 4:15 - 5:00   | Lecture 8          |
| 7:30 - 9:00   | cash bar/reception |

CHAIR: HARRY SWINNEY

- 3:15 - 4:00 I. Epstein (Brandeis), *Recent studies of Turing patterns\**  
 4:00 - 4:20 R. Rollins (Ohio University), *Controlling chaos in highly dissipative systems*  
 4:20 - 4:40 A. Huebler (Illinois), *Optimal control of chaos*  
 4:40 - 5:00 M. Silber (Caltech), *Spatially and temporally periodic pattern formation in euclidean equivariant systems*  
 5:00 - 5:20 S. Natsiavas (Arizona State Univ.), *Local bifurcations and modal interactions in a mechanical model of metal cutting chatter*  
 5:20 - 7:30 Dinner

## WEDNESDAY, JANUARY 6 Conference begins

CHAIR: ERIC KOSTELICH

- 8:45 - 9:00 Opening remarks  
 R. Barnhill (Vice President for Research, Arizona State University)  
 M. Shlesinger (Director, Physics Division, Office of Naval Research)  
 9:00 - 9:45 A. Newell (Univ. of Arizona), *Dynamical patterns\**  
 9:45 - 10:05 W.-J. Rappel (CNRS and Univ. of Paris), *Dynamics of the globally-coupled complex Ginzburg-Landau equation*  
 10:05 - 10:25 H. Greenside (Duke), *Does a power-law power spectrum imply self-affinity?*  
 10:25 - 11:15 Poster session 1

CHAIR: ERIC KOSTELICH

- 11:15 - 12:00 C. Grebogi (Univ. of Maryland), *Using time series for feedback control of chaotic systems\**  
 12:00 - 1:00 Lunch

CHAIR: BOB BEHRINGER

- 1:00 - 1:45 R. Roy (Georgia Tech), *Nonlinear dynamics of a solid state laser system: from chaos to control\**  
 1:45 - 2:05 I. Schwartz (Naval Research Lab), *Tracking unstable periodic orbits in experiments: a new continuation method*  
 2:05 - 2:25 M. Muldoon (Univ. of Warwick), *Topology from time series*  
 2:25 - 3:15 Poster session 2

CHAIR: ERIC KOSTELICH

- 7:30 - 8:15 N. Gershenfeld (MIT), *Predicting the future and understanding the past: results from the Santa Fe Institute time series competition\**  
 8:15 - 9:00 S. Kauffman (Santa Fe Institute), *Co-evolution to the edge of chaos\**

## THURSDAY, JANUARY 7

CHAIR: PETER CROUCH

- 8:30 - 9:15 A. Bloch (Ohio State), *The dynamics of gradient and Hamiltonian flows and convexity\**  
 9:15 - 9:35 J. Bartholdi (Georgia Tech), *A production line that balances itself*  
 9:35 - 9:55 P. Worfolk (Cornell), *Instant chaos*  
 9:55 - 10:45 Poster session 3

CHAIR: EMILY STONE

- 10:45 - 11:30 J. Yorke (Univ. of Maryland), *Numerical trajectories of chaotic systems\**  
 11:30 - 11:50 M. Isichenko (Univ. of Texas, Austin), *Hamiltonian attractors*  
 11:50 - 12:10 A. Hanslmeier (Univ. of Graz, Austria), *Pattern formation and turbulence in the solar atmosphere*  
 12:10 - 1:15 Lunch

CHAIR: BOB BEHRINGER

- 1:15 - 2:00 J. Carlson (Univ. of California, Santa Barbara), *Self-organized criticality: applications of singular diffusions\**  
 2:00 - 2:45 J. Socolar (IBM and Duke), *Origins of long range correlations in 1D sandpiles\**

\*Invited Speaker

# DYNAMICS DAYS

## INFORMATION SHEET

**Registration desk and message board:** Located in the ballroom lobby, the registration desk will be open from 7:30 a.m. until 5:00 p.m. each day. A message board is located in the ballroom lobby. To leave a message for a conference participant, call the hotel switchboard and ask for the Dynamics Days registration desk. Pay telephones and restrooms are located in the southeast corner of the ballroom lobby.

**Posters and preprints:** Poster boards and preprint tables are located adjacent to the main ballroom. This room will be open until 9 p.m. each day. Posters may be set up on Tuesday evening and should be taken down by Saturday morning.

**Book displays:** All books are located in the Dolores Room, which will be open until 6 p.m. on Wednesday, Thursday and Friday. The following publishers are represented:

*Springer-Verlag*

*Elsevier*

*World Scientific*

*Addison-Wesley*

*IOP Publishing*

*Marcel Dekker*

*Gordon & Breach*

*MIT Press*

*American Institute of Physics*

*Society for Applied & Industrial Mathematics*

**Wind tunnel tours:** Tours of the ASU Wind Tunnel Facility, run by Prof. William Saric, will be held on Thursday afternoon from 1 to 3 o'clock. If you are interested, please sign up on the roster located next to the message board. Vans will depart from the hotel lobby at approximately half-hour intervals. The tour will take about 30 minutes.

**Short course luncheon:** A buffet lunch will be served to all participants in the short course on Tuesday, January 5 in the Mission Room.

**Refreshments:** Coffee and soft drinks will be served during the breaks each morning and afternoon in the ballroom lobby.

**Restaurants:** The hotel requests that you make reservations if you plan to eat at any of their restaurants in groups of more than four people.

A guide to restaurants in Tempe is included in your conference packet. Additional sandwich shops and a soup and salad bar are located in Tempe Center at the southeast corner of Mill Avenue and University Drive, about 10 minutes' walk from the hotel.

**Audiovisual equipment:** Two overhead projectors and a 35 mm slide projector will be available at all times. A VHS video projector will be available on Friday, Jan. 8. Please see Robert Hedges if you have slides or videotapes.

**Financial aid:** If you are receiving travel reimbursement or financial aid, please complete and sign the form included in your conference folder. A check will be mailed to you in 2 to 4 weeks.

**Banquet:** A cash bar will be located in the ballroom lobby from 5:45 to 6:45 on Thursday afternoon. The banquet will be held in the Cloister Room at 6:45 p.m. Unfortunately, Allan Bromley had to cancel his talk at the last minute, so there will not be a session on Thursday evening following the banquet.

### **Useful telephone numbers:**

Mission Palms: (602) 894-1400 (voice); (602) 968-7677 (fax)

ASU Mathematics department: (602) 965-3951

# DYNAMICS DAYS ARIZONA

## POSTER SESSION SCHEDULE (REVISED)

|                          |   |
|--------------------------|---|
| Wed. Morning, Jan. 6:    | Posters 1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61, 67, 73, 79, 85          |
| Wed. Afternoon, Jan. 6:  | Posters 2, 8, 14, 20, 26, 32, 38, 44, 50, 56, 62, 68, 74, 80, 86, 92      |
| Thur. Morning, Jan. 7:   | Posters 3, 9, 15, 21, 27, 33, 39, 45, 51, 57, 63, 69, 75, 81, 87, 93      |
| Thur. Afternoon, Jan. 7: | Posters 4, 10, 16, 22, 28, 34, 40, 46, 52, 58, 64, 70, 76, 77, 82, 88, 94 |
| Fri. Morning, Jan. 8:    | Posters 5, 11, 17, 23, 29, 35, 41, 47, 53, 59, 65, 71, 83, 89, 95         |
| Fri. Afternoon, Jan. 8:  | Posters 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96     |

## LIST OF POSTER PRESENTATIONS

1. Paul Alsing, *Controlling chaos in semiconductor laser devices*
2. Guido Arnone (Univ. of Texas, Austin), *Advection-diffusion reaction on lattices of variable homogeneity*
3. Lance Arsenault (Univ. of Illinois, Urbana), *Dynamics of coupled oscillators near resonance*
4. Ernest Barany (New Mexico State University), *Detecting the symmetry of attractors: symmetry in systems with complicated dynamics*
5. Steve Robinson and John Baxley (Wake Forest University), *Nonhomogeneous diffusion in the chemostat*
6. Christopher Begley and S. Natslavas (Arizona State University), *Nonlinear response spectra of unanchored liquid storage tanks*
7. Daniel Bensen (Univ. of Illinois), *The geometry of nonlinear resonance curves of Duffing systems*
8. Ofer Biham (Syracuse University), *Systematic calculations of unstable periodic orbits in the stadium billiard*
9. Ofer Biham (Syracuse University), *Self organization and a dynamical transition in traffic flow models*
10. Hans Blank (Physikalisches Institut des Universität Erlangen), *Dimension and entropy analysis of experimental systems using the DSD method*
11. Moses Boudourides (Univ. of California, Irvine and Democritus University of Thrace, Greece), *Finite dimensional behavior of penetrative convection*
12. Jeff Brush (RTA Corp.), *System discrimination in noise*
13. Mark Buchanan (Univ. of Virginia), *Superimposed small-amplitude nonlinear plasma waves*
14. Radmila Bulajich (Univ. Autonoma de Mexico), *Phenomenological renormalization group for cellular automata*
15. Ricardo Carretero (Inst. de Fisica, Univ. Autonoma de Mexico), *Testing a stochastization criterion for Hamiltonian systems*
16. Kenneth Chang (Univ. of Illinois at Urbana-Champaign), *General resonance spectroscopy using the double scroll oscillator*
17. S. S. Chen (Argonne National Laboratory), *Chaotic vibration of tube arrays in crossflow*
18. Alexander Chernikov (Stevens Institute of Technology), *Diffusion on stochastic webs near the percolation threshold*
19. Pere Colet (Georgia Tech), *Theoretical study of the control of chaos in a multimode solid state laser*
20. Rebecca Crabb (McGill Univ.), *Spatio-temporal bifurcation in a retarded PDE*
21. Yunson Du (Univ. of Maryland), *Sign-singular measures: fast magnetic dynamos and high Reynolds number fluid turbulence*
22. Michael Dueweke (Univ. of Illinois at Urbana-Champaign), *Stable stationary dendritic structures and minimum resistivity*
23. Jin-Qing Fang (Beijing), *Inverse operator method for studies of chaotic behaviors in nonlinear physics*
24. David Farrelly (Utah State Univ.), *Normalization and the detection of integrability*
25. Edelfredo Garcia (Arizona State Univ.), *True and false numerical dynamics in chemical equilibrium calculations: introducing the arm approach*
26. Ricardo Garcia-Pelayo (Univ. of Texas, Austin), *Gutenberg-Richter law for starquakes*
27. Ricardo Garcia-Pelayo (Univ. of Texas, Austin), *Chaotic pattern bases for cellular automata*
28. Jim Hanson (Berkeley), *Chaotic pattern bases for cellular automata*
29. Andreas Herz (California Institute of Technology), *Unexpected simplicity in nonlinear systems with delayed feedback*
30. Andreas Herz (California Institute of Technology), *Where Hebb and Lyapunov meet: global analysis of complex dynamical systems*
31. James Howard (Utah State Univ.), *Chaotic dynamics of ion traps*
32. Alfred Huebler (Univ. of Illinois, Beckman Institute), *Optimal control of chaos*
33. John Huth (Univ. of Texas, Austin), *The role of convection in electrochemical growth*
34. Michael Isichenko (Univ. of Texas, Austin), *Effective and anomalous diffusion in laminar Benard convection*
35. Juan Jimenez (Univ. Central de Venezuela), *Reordering chaotic time series in which irrelevancy is present*
36. Michael Jorgensen (Technical Univ. of Denmark), *On a modified discrete self-trapping dimer*
37. James Kadtko and Jeff Brush (RTA Corp.), *Adaptive phase space modeling of chaotic time series*
38. Roland Ketzmerick (Univ. of Frankfurt and UCSB), *Chaotic electrons and their regular adventures in transport measurements*

39. Aaron Klebanoff and Carlos Puente (Univ. of California, Davis), *Fully developed turbulence, plane-filling fractal functions and Brownian motion*
40. Robert Klevecz (Beckman Research Institute), *Self-organization and fixed patterns emergent in coupled chaotic arrays*
41. R. M. Klehn (Univ. of Houston), *Spiral instability patterns, hydrodynamic wakes and minimal surfaces*
42. J. M. Koehler (Institut für Physikalische Hochtechnologie, Jena, Germany), *Chaos and order in an open-circuit system of coupled electrochemical oscillators*
43. Allstair Kyle (McGill Univ.), *Periodic forcing of the Fitzhugh-Nagumo equations*
44. Aadam Landsberg (Univ. of California, Berkeley), *Spatial symmetries and geometrical phases in dissipative systems*
45. Sarah Little (Woods Hole Oceanographic Institute), *Nonlinear data analysis of a predator-prey-nutrient system*
46. Jerome Losson (McGill Univ.), *Dynamics of coupled DDE lattices: pattern formation and bifurcation*
47. J. H. Lowenstein (New York Univ.), *Quasicrystalline structure of the fivefold stochastic web map*
48. Ronnie Mainieri (Los Alamos National Lab), *Exactly solvable chaotic systems*
49. Jian-min Mao (Hong Kong Univ.), *Bifurcations in quantum systems*
50. Gottfried Mayer-Kress (CCSR-Univ. of Illinois), *Wavelets and spatiotemporal chaos*
51. Robert Mettin (Th. Darmstadt), *Bifurcation structure of the driven Van der Pol oscillator*
52. Mark Millonas (Los Alamos National Lab), *Stochastic chaos: an analogue of quantum chaos*
53. Mark Millonas (Los Alamos National Lab), *Sward field dynamics and functional morphogenesis*
54. Jose Moreno (Univ. Central de Venezuela), *Noise reduction with neural networks*
55. James Murdock (Iowa State Univ.), *Shadowing multiple elbow orbits*
56. Daniel Murray (Okanagan Univ. College), *Forecasting using optimal metric for embedding space*
57. Irina Nechayeva (McGill Univ.), *Noise and stability in differential delay equations*
58. Helen Nelson (Univ. of Texas, Austin), *A quantum chaotic system: an electron in a one-dimensional lattice*
59. Hilda-Noemi Nunez-Lopez (UAM-Iztapalapa), *A covariant prescription for chaos in cosmological models*
60. Akhtar Khan (Univ. of Southern Mississippi), *Traveling fronts of addition polymerization*
61. Punli Parmananda (Ohio Univ.), *Experimental control of chaos in an electrochemical cell*
62. Arjendu Pattanayak (Univ. of Texas, Austin), *The quantum Duffing oscillator, Melnikov function, and homoclinic chaos*
63. Raul Rechtman (Univ. Autonoma de Mexico), *Damage spreading and Lyapunov exponents in cellular automata*
64. Guillermo Ruggeri (Univ. Central de Venezuela), *Detecting chaos with local associative memories*
65. Alvaro-L Salas-Brito (UAM-Axcapotzalco), *A covariant prescription for chaos in cosmological models*
66. Kevin Sandusky (Arizona State Univ.), *Stability and motion of intrinsic localized modes in nonlinear periodic lattices*
67. Daniel Schertzer (Univ. P. M. Curie, Paris), *Divergence of moments of the energy flux in turbulence: empirical determination and consequences*
68. Daniel Schertzer (Univ. P. M. Curie, Paris), *Generic first order phase transitions in multifractal processes and self organized criticality*
69. Daniel Schertzer (Univ. P. M. Curie, Paris), *Lie cascades and high dimensional chaos*
70. Daniel Schertzer (Univ. P. M. Curie, Paris), *Conditionally soft/hard multifractality in hadrons-hadrons collisions*
71. Thomas Schreiber (Niels Bohr Institute), *Nonlinear noise reduction: a case study*
72. Vijay Sheorey (Physical Research Lab, Ahmedabad, India), *Structures in high excitation eigenstates of chaotic quantum systems*
73. Russel Sherner (Naval Surface Warfare Center), *Determining parametric time dependencies for entrainment controls*
74. Paul So (Univ. of Maryland), *Observing chaos*
75. Stanislav Soloviyov (Univ. of Southern Mississippi), *Modes of reacting liquid flow with changing viscosity*
76. K. Skiskandarahajah (Iowa State Univ.), *Global bifurcation of the forced Duffing equation*
77. Jim Swift (Northern Arizona Univ.), *Unfolding the torus: oscillator geometry from time delays*
78. Jack Swift (Univ. of Texas, Austin), *Noise and onset in Rayleigh-Benard convection*
79. George Szpilo (U. of Zurich), *Cycles and circles in roundoff errors*
80. James Theller (Santa Fe Institute and LANL), *Surrogate data*
81. Sten Thore (IC2 Institute, Univ. of Texas, Austin), *Most U.S. computer corporations are far off equilibrium*
82. Yuhai Tu (Caltech), *Chaotic domain structure in rotating convection*
83. Nicholas Tufillaro (CNLS, Los Alamos), *Braid analysis of low dimensional chaotic time series*
84. Kwok-Yeung Tsang (Naval Research Lab), *Stability analysis of degenerate out-of-phase states in coupled Josephson junction arrays*
85. Burton Voorhees (Athalasca Univ.), *Commutation of cellular automata rules*
86. Nicholas Weber (Univ. of Illinois), *Optimal adaptation*
87. Han-Long Yang (Simon Fraser Univ.), *On a sliding mode observer*
88. Kenton Yee (Louisiana State Univ.), *A simulation of magnetic monopoles and Dirac string vortices*
89. Limin Zhang (Washington State Univ.), *A nonlinear stability analysis of a unified aerosol model for thin layer Rayleigh-Benard convection*
90. Gaja, Ivan (Univ. of Maryland), *Convergence of an infinite product of Lie transformations*
92. Dmitry Gupalo (Rockefeller Univ.), *Symmetry of the Lyapunov spectrum*
93. Manfred Lücke (Saarbrücken), *The effect of amplitude variations on phase dynamics*
94. Steve Hammel (NSWC), *Strange nonchaotic attractors and the quasiperiodic Ikeda map*
95. Pat Carter (NSWC), *Geometry of time series using wavelets*
96. Xiaogin Zou (U.C. San Diego), *Standing waves in catalysis at single crystal surfaces*

# Revised Poster List

Additions and corrections

January 7, 1993

The posters below replace the ones in the original list:

- 28. **Jim Hanson** (Berkeley), *Chaotic pattern bases for cellular automata*
- 60. **Akhtar Khan** (Univ. of Southern Mississippi), *Traveling fronts of addition polymerization*
- 90. **Gjaja, Ivan** (Univ. of Maryland), *Convergence of an infinite product of Lie transformations*
- 92. **Dmitry Gupalo** (Rockefeller Univ.), *Symmetry of the Lyapunov spectrum*
- 93. **Manfred Lücke** (Saarbrücken), *The effect of amplitude variations on phase dynamics*
- 94. **Steve Hammel** (NSWC), *Strange nonchaotic attractors and the quasiperiodic Ikeda map*
- 95. **Pat Carter** (NSWC), *Geometry of time series using wavelets*
- 96. **Xiaogin Zou** (U.C. San Diego), *Standing waves in catalysis at single crystal surfaces*

Corrected title for number 52.: *Stochastic chaos: an analogue of quantum chaos*

New poster 77 which will be presented Thursday afternoon, Jan. 7:

**Jim Swift** (Northern Arizona Univ.), *Unfolding the torus: oscillator geometry from time delays*

Poster 10 (corrected title): *Dimension and entropy analysis of experimental systems using the DSD method*

**Schedule change for Thursday morning, Jan. 7:**

**Michael Isichenko** will speak from 10:30–11:50.

**John Bartholdi** will speak from 9:15–9:35.

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